

Amory (Robt's)

A CONTRIBUTION

TO THE

HÆMATINIC PROPERTIES OF DIALYZED IRON.

BEING EXTRACTS FROM COMMUNICATIONS READ BEFORE THE BOSTON
SOCIETY OF THE MEDICAL SCIENCES AND THE BOSTON SOCIETY
FOR MEDICAL OBSERVATION.

✓
BY

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OF LONGWOOD, MASS.

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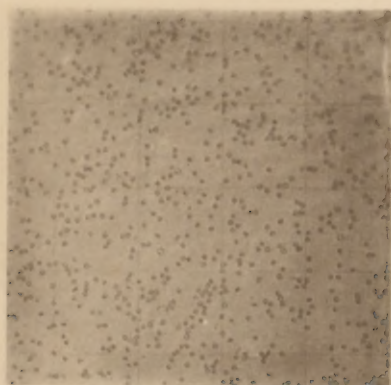
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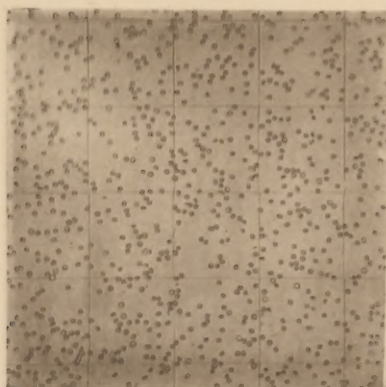
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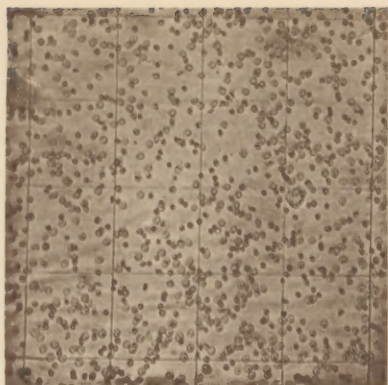


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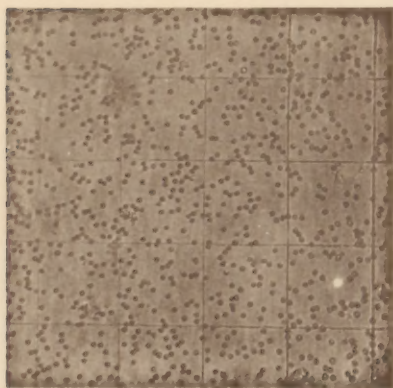
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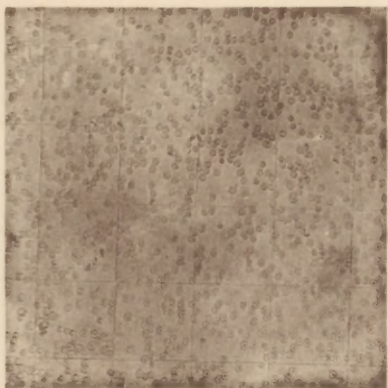
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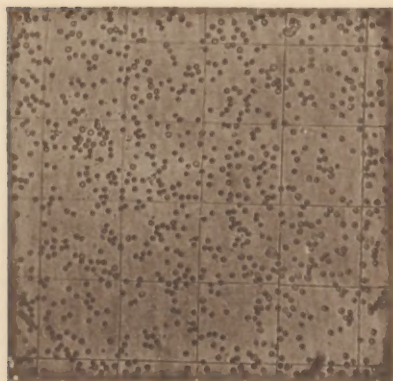
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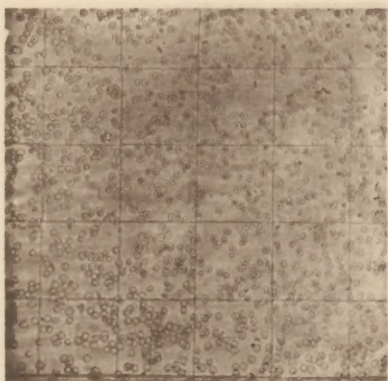
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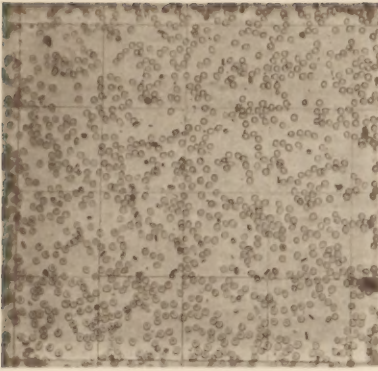
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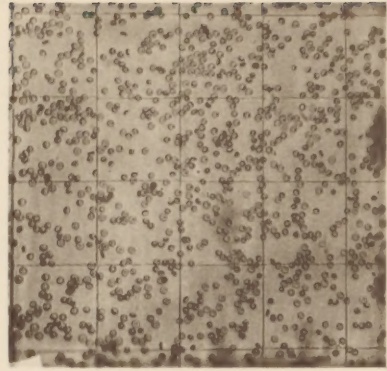
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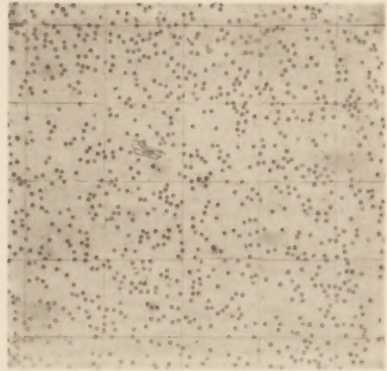
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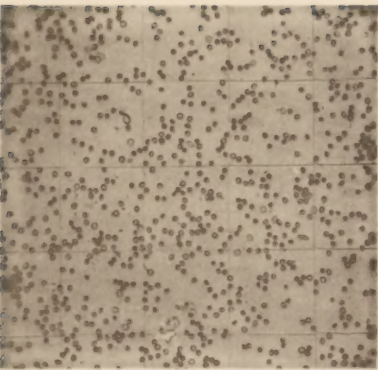
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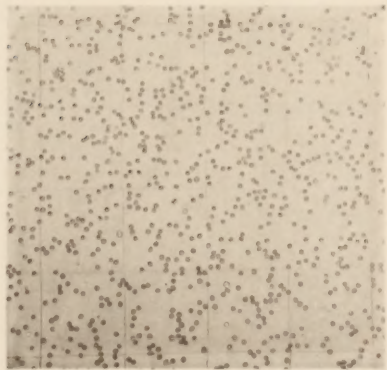
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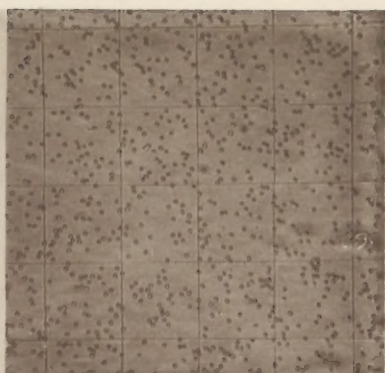
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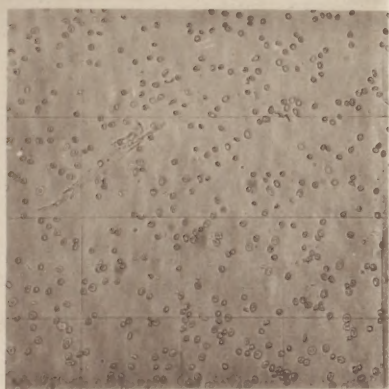
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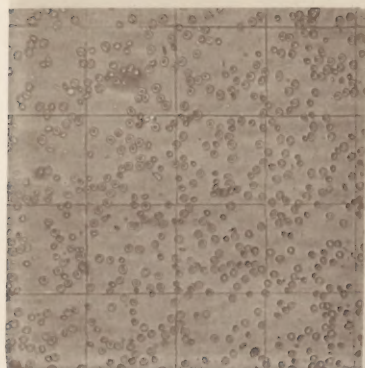
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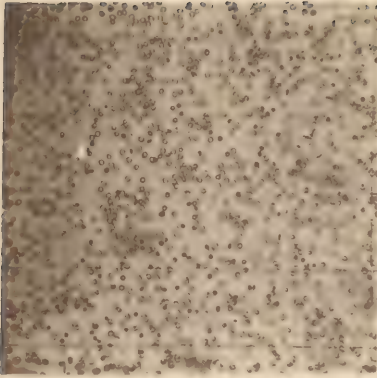
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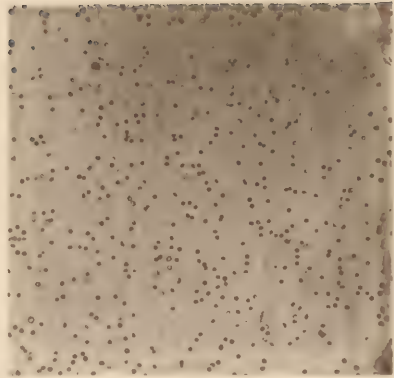
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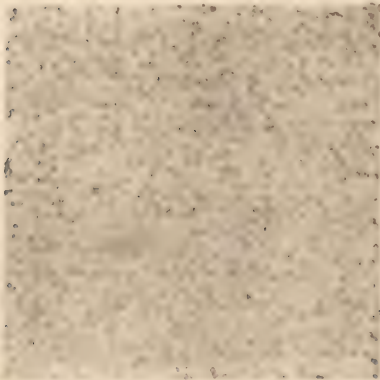
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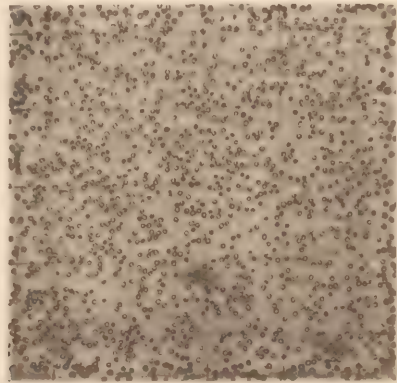
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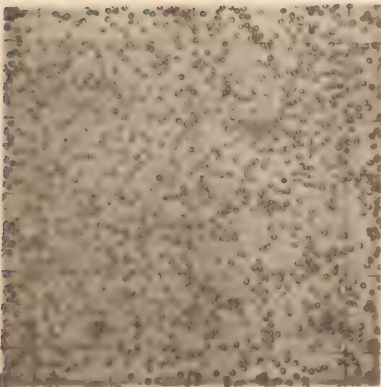
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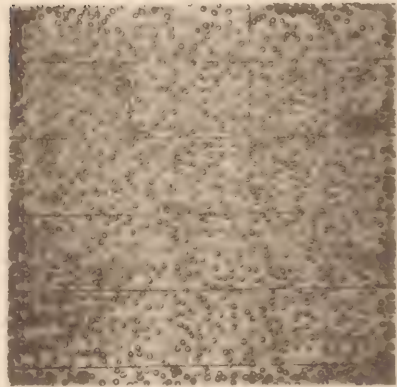
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EXPERIMENTS AND CLINICAL OBSERVATIONS
ON THE
HEMATINIC PROPERTIES OF DIALYZED IRON.¹

BY ROBERT AMORY, M. D.

GOWERS's hamacytometer, the instrument I used in the following observations, consists of a glass slide upon which are ruled squares one tenth of a millimetre in extent, and these are inclosed in a cell one fifth of a millimetre in depth. This slide can be used with any microscope, and with a lens of any desirable magnifying power; moreover, the magnified image of the slide may be projected by means of a prismatic eye-piece upon a screen. The principle of Malassez's "compte globule" does not admit of either of these convenient methods of delineation. In addition to the ruled slide there are two pipettes, one of which holds nine hundred and ninety-five cubic millimetres, and the other five cubic millimetres. The principle and method of using this instrument are then based upon the following facts: If a known measure of blood be carefully drawn from an acupuncture, and intimately mixed with two hundred times its volume of a saline solution (specific gravity 1.025) having a density sufficient to prevent the corpuscles from imbibing water, and so bursting their envelopes, these corpuscles, separated from each other, will float in this mixture, and will finally settle down to the bottom of the containing vessel or dish.

In this manner a small portion of the mixed or diluted blood is placed in the above-described cell, and the corpuscles are allowed to settle to the bottom, so as to be nearly on the same plane as the ruled lines, and are pretty uniformly distributed. The number of corpuscles in ten contiguous squares can then be readily counted, and this sum multiplied by the figure ten thousand will give the number of corpuscles in each cubic millimetre of the pure or originally drawn blood; because ten cubes, each one of which has the dimensions $\frac{1}{10} \times \frac{1}{10} \times \frac{1}{5}$ millimetres (or $\frac{1}{500}$ of a cubic millimetre), will contain $\frac{1}{50}$ of a cubic millimetre, and since the original blood was diluted with two hundred volumes, the number of corpuscles actually counted in the ten squares must be multiplied by two hundred times fifty, or ten thousand, in order to obtain

¹ Read before the Boston Society of Medical Sciences, January 21, 1879, and the Boston Society for Medical Observation, March 17, 1879.

the number in each cubic millimetre of undiluted blood. If we wish still further to separate the corpuscles from each other, we may use four hundred volumes of the diluent to one of the blood, but in that case we must either count the corpuscles in twenty squares and multiply by ten thousand, or count those in ten squares and multiply by twenty thousand.

The individual or personal error of vision which is associated with all optical instruments is perhaps somewhat difficult to reduce to mathematical accuracy, on account of the fact that constant observation fatigues the eyesight, and hence the results of a series of these observations are subject to an inconstant variation. In consequence of this apparent difficulty, I decided to project upon a photographic plate the image of the corpuscles on the ruled slide, then to print from the negatives, and count upon the print the number of these corpuscles, each one being obliterated as soon as counted.

To show the range of error of this method of obtaining the proportion of globular richness of the blood, I will call your attention to the prints Nos. 1, 2, 3, 4, which were all taken from blood of the same individual from four different punctures, separately diluted, and a sample from each dilution separately photographed.

No. 1	shows	4,656,000	corpuscles	per	cubic	millimetre. ¹
No. 2	"	4,750,000	"	"	"	"
No. 3	"	4,633,000	"	"	"	"
No. 4	"	4,673,000	"	"	"	"

The greatest difference between these four results being only 117,000 shows less than three per cent. of variation. Again, in three separate photographs, taken from one sample on the same slide, a field at either periphery, and at its centre, the variation was even less than that above mentioned. Thus, so far as this method is concerned, the error of variation may be placed within three per cent.

Hearing from certain members of our profession expressions which indicated a skeptical distrust in regard to the virtues of the solution of dialyzed iron, I was induced to undertake a series of observations upon the hæmatinic properties of this medicinal agent, and yet I must frankly acknowledge in advance that my own clinical experience with this form of iron had led me to attach to it a value in simple anæmia, and to place this remedy by the side of Quevenne's iron. I have taken pains to inquire how much metallic iron is contained in the so-called dialyzed iron, and learn that a sample of the sealed dialyzed iron as prepared by one of our large wholesale druggists has been analyzed by Prof. Charles

¹ A reference to the prints will show not more than sixteen squares represented. On the original photographic prints presented at the meetings the count gave an average for twenty-five or thirty squares. To have reproduced this number of squares in each heliotype print would have required too much room. Hence a discrepancy between the numbers of corpuscles mentioned in the text and what may be counted in the illustrations may be explained.

M. Cresson, of Philadelphia, and that he found it to contain fifty-two per cent. of metallic iron, or over seventeen per cent. more than is contained in the sesquichloride of iron; compared with the sesquichloride it is equally soluble, keeps without change, does not corrode the teeth or fabrics with which it may be brought in contact, and contains a greater percentage of iron. The manufacturer from whom this sample was obtained claims that his solution of dialyzed iron has over twenty grains of ferric oxide in each ounce of solution, and in proof of this has shown me a certificate from Prof. F. A. Genth, of the University of Pennsylvania, that a sample of his manufacture, which was purchased by the latter from a retail druggist in Philadelphia, contained 21.69 grains of ferric oxide in each ounce of solution.

The following table of assays of various iron preparations was made by M. Quevenne. One gramme (fifteen grs.) of the following preparations was soluble in two hundred grammes of gastric juice in the proportions named:—

Of 1.0 iron by hydrogen containing 1.000 pure iron was dissolved	0.102 pure iron.
Of 1.0 iron filings	“ 1.000 “ “ “ “ 0.070 “ “
Of 1.0 protosulphate of iron	“ 0.210 “ “ “ “ 0.056 “ “
Of 1.0 protocarbonate of iron	“ 0.490 “ “ “ “ 0.050 “ “
Of 1.0 persulphate of iron	“ 0.250 “ “ “ “ 0.046 “ “
Of 1.0 lactate of iron	“ 0.190 “ “ “ “ 0.040 “ “
Of 1.0 protochloride of iron	“ 0.430 “ “ “ “ 0.036 “ “
Of 1.0 tartrate of iron and potass	“ 0.210 “ “ “ “ 0.022 “ “
Of 1.0 oxide of iron heated to red heat	“ 0.700 “ “ “ “ 0.016 “ “

Forty parts of scaled or dialyzed iron from which water had been withdrawn without aid of heat was levigated very fine and placed in an artificial gastric juice prepared as follows: five parts hydrochloric acid and acetic acid, fifteen parts of pure pepsin, with traces of chlorides of sodium, potassium, and ammonium; also phosphates iron, lime, and magnesium in one thousand parts of water; and temperature was maintained at 100° F. for five hours, then filtered through a “tared” filter, dried and weighed, showing a loss of iron amounting to fifteen parts. This shows that 3.00 grammes of scaled dialyzed iron (containing 1.5 grammes pure iron) are soluble in two hundred grammes of gastric juice.

Having thus compared the properties of dialyzed iron with other well-known preparations, I will report five cases only, in which I observed its effect upon the globular richness of the blood. These were cases of simple anæmia uncomplicated by organic disease, and none of the individuals were placed upon any regimen of diet or exercise, but were allowed to continue their usual habits of life. My object was to prevent

the error of attributing any improvement in health or appearance to an improved diet, or to the more favorable effects of fresh air and exercise. I selected those cases in which I could personally observe the individuals from day to day, and could note any peculiarity of symptoms or unusual mode of life. The instrument which I imported from London was so inaccurate that I was forced to abandon it, as well as the reports of three cases in which it was used, and obtained from Prof. W. A. Rogers, of Harvard College Observatory, some very accurately ruled glass slides. I also procured some pipettes, and carefully estimated their capacity, so that I could place more reliance upon their measurements. I took especial care in the photographs herewith presented not to use various pipettes or ruled slides in the same individual; in the few cases in which (owing to accidental breakage) I was obliged to use more than one set of apparatus, the second set was carefully measured anew, so that my comparative results should not be invalidated.

The circumstances under which the blood was taken from the patient were as nearly similar as possible, and I have a strong confidence that the results of my observations are not materially affected by the method of procedure, and that the error of variation may be safely placed within five per cent. I have not the time in this communication to prove the grounds for this statement, nor would it be worth your while to examine the details of experiment which were used to determine my opinion. The pains that have been taken may perhaps be better appreciated by the careful examination of two hundred photographs, taken under various circumstances and conditions, among which may be mentioned the temperature of the surface after exposure to dry and wet heat and cold, the depth and method of puncture of the skin, blood taken while the patient was depressed by pain or temporary disturbances of other sorts, during the menstrual flow, and before rising from bed in the morning. The variation shown in these photographs is not to my knowledge dependent upon any of these disturbing causes.

CASE I. is that of a woman whose appearance was anæmic, and, as far as I could learn, had no organic disease. An earlier examination of her blood had shown about 3,900,000 corpuscles per c. mm. of blood, but this negative was unfortunately lost. The print No. 5 was taken on the third day after the commencement with the solution of dialyzed iron. I have estimated in this 4,189,000 corpuscles per c. mm., or about eighty-three per cent. of the normal state of health. At first she took her medicine quite regularly, and in ten days gained 171,000 corpuscles, her blood having attained a percentage of eighty-six. The following six days she took the medicine very seldom, and lost 500,000 corpuscles, and was in the same anæmic condition as before treatment, having a percentage of seventy-six. From this time onward she took the medicine more faithfully, but still omitting one dose about every

two or three days, and in five days regained 440,000 corpuscles, having now a percentage of eighty-four. In another week she gained 60,000, and in four days more 160,000, having then a percentage of ninety-six. In the whole period, from December 11th to January 10th, this patient showed an increase of 1,000,000 corpuscles, or an improvement of twenty per cent. During the whole time she was under observation she menstruated twice, but apparently with very slight effect upon the globular richness of the blood. None of these prints, Nos. 5, 6, 7, 8, 9, 10, 11, were taken during menstruation.

No. 5.	December	5th,	4,189,000, or 83 per cent.	
No. 6.	"	13th,	4,360,000, or 87 per cent.	
No. 7.	"	19th,	3,850,000, or 77 per cent.	(Has taken iron seldom.)
No. 8.	"	24th,	4,240,000, or 84 per cent.	
No. 9.	"	31st,	4,630,000, or 92 per cent.	
No. 10.	January	6th,	4,820,000, or 96 per cent.	
No. 11.	"	10th,	4,860,000, or 97 per cent.	

CASE II. is that of a girl about sixteen years of age, who consulted me for neuralgia, dizziness, especially during the act of stooping, lassitude, and general malaise; she had the habit of awaking with a slight headache, which, towards the latter part of the day, forced her to leave her regular household duties. She had been out to walk two or three times a day, and, like all the other cases, had but slight loss of appetite, a good home, good food, warm clothing, without much requirement for excessive mental or physical work. Her catamenia occurred too frequently, once in three weeks. Without advising any change in diet or occupation, I gave her in water, as in all the other cases, thirty drops of dialyzed iron solution three times a day. I may as well say here that I obtained the solution of dialyzed iron always from the same manufacturer, furnished it directly to each patient, and that it had a uniform standard and purity, so far as I could determine. Its specific gravity was 1042, and in two instances the solid residue was about twenty-four grains to the ounce of solution. The record of Case II. is estimated from the prints:—

No. 12.	December	16th,	4,070,000, or 80 per cent.	(Began treatment.)
No. 13.	"	20th,	4,220,000, or 84 per cent.	
No. 14.	"	28th,	4,370,000, or 87 per cent.	
No. 15.	January	6th,	4,620,000, or 92 per cent.	(Discontinued treatment.)
No. 16.	"	15th,	4,500,000, or 90 per cent.	

All her anæmic symptoms, above mentioned, gradually disappeared, and she omitted the treatment because she felt well, and up to the present time none of these symptoms have reappeared.

CASE III. is that of a young woman about twenty years of age, pale and thin in appearance, who has at previous times been much improved by a ferruginous tonic treatment. She complained of languor, dizziness, muscular fatigue, cold, moist hands, painful menstruation, etc. Estimates from prints:—

- No. 17. December 17th, 3,700,000, or 74 per cent. (Began treatment.)
 No. 18. " 31st, 4,700,000, or 94 per cent.
 No. 19. January 15th, 4,200,000, or 84 per cent. (Having a headache.)
 No. 20. " 17th, 4,600,000, or 92 per cent.

Apparently, on January 15th, her headache caused a diminution in globular richness, and for the sake of comparison I show print No. 21 of my own blood, taken during a headache: ordinarily my blood shows over 5,000,000 corpuscles per c. mm.; the number estimated by this print is only 4,350,000.

CASE IV. is that of a clergyman, who had been suffering from neuralgia, headache, an uncomfortable feeling of pressure in the head, and general malaise; these symptoms were aggravated after mental or physical work. Though actively engaged in his professional duties, he led a healthy life, took daily exercise, eating well and at regular times. He had been taking a few weeks previously Carlsbad water, though he had no indigestion or constipation. His record is as follows: Omitting Carlsbad water, he began, December 3d, dialyzed iron solution, half a teaspoonful, diluted with water, three times a day, after meals, and taken regularly; he omitted only one dose during five weeks' treatment. The estimate from the prints is:—

- No. 22. December 3d, 3,800,000, or 76 per cent.
 No. 23. " 13th, 4,500,000, or 90 per cent.
 No. 24. " 28th, 5,191,000, or 103 per cent.
 No. 25. January 6th, 4,900,000, or 98 per cent.
 No. 26. " 16th, 4,500,000, or 90 per cent. (The day after a headache, and iron omitted.)

This was the only headache he had while taking the iron, and his professional work about Christmas time was excessive.

CASE V. A married woman, who has had chlorosis and anæmia for several years, her appearance being white and bloodless, has been a patient of Dr. Sabine's for two years, and her chronic anæmia has been a marked feature; apparently she has no organic disease other than this impoverishment of blood. Figure 27 indicates that the globular richness of blood is only 3,350,000, and at that time she began treatment by dialyzed iron. On one of the last days of February she had diarrhœa, with some catarrh of intestines, which was controlled in two or three days by ordinary doses of morphine and chalk mixture. On March 3d, after a fortnight's use of the solution of dialyzed iron (Figure No. 28), her globular richness had improved to 3,560,000 in spite of the diarrhœa. On March 19th another examination showed 3,600,000 corpuscles per c. mm.

There certainly is good reason for saying that four or five cases are insufficient to establish definitely that the solution of dialyzed iron cures anæmia. However, an analysis of the history of these cases shows that all the individuals were in comfortable circumstances, as far as food, clothing, and homes were concerned; that none of them had any organic

disease (if we except simple impoverishment of the blood); that they were aware of being out of their usual health; that they were unable to accomplish their regular work; that none had impaired appetite, nor feeble digestion; that three of the four suffered from neuralgia or headache; finally, all had diminished corpuscular richness of blood, varying from 3,350,000 to 4,000,000, and that under the continued use of ninety drops of solution of dialyzed iron per diem this condition of impoverished blood was replaced by an increase in the number of corpuscles, from 3,600,000 to 4,900,000, and the symptoms of ill health simultaneously disappeared with this improvement.

Dialyzed iron may increase the globular richness of blood, but it may have no effect in bringing about the chemical combination of oxy-hæmoglobin. If the supposition be true that there is a state of ill health in which the corpuscles may be numerically normal, but may simultaneously be deficient in coloring matter, we may conceive of an anæmic or chlorotic patient who may require some therapeutical means for improving this deficiency other than simple iron. I may have been extremely fortunate in selecting just those cases in which a simple form of iron was indicated, and it may not be impossible that another form would have benefited my cases as much as the dialyzed iron; yet the latter is preferable to the more astringent iron salts, because it does not impair the digestion, nor produce constipation.

I cannot close my communication without an expression of thanks to Dr. Sabine and my laboratory assistant, Mr. J. G. Hubbard, whose material assistance lent much to the value of the record of these experiments.

Now, one final word about the various solutions of dialyzed iron. Many of these solutions are valueless, some are very dilute, and a few are of pretty uniform standard, and contain only the products of dialysis from a salt of iron and distilled water. If physicians use a worthless preparation, they need not expect an improvement in the anæmia; if they use a dilute solution, they must prescribe a larger amount of the solution.¹ In the preparation I used for these experiments the solution had a specific gravity of 1042, and had no free acid.

¹ See Bost. Med. and Surg. Journal, September 21, 1878.



